DOCUMENT RESUME

ED 174 741 UD 019 709

AUTHOR Mare, Robert D.; Mason, William M.
TITLE A Multiple Group Measurement Model of Children's Reports of Parental Socioeconomic Status. Discussion Papers No. 531-78.
INSTITUTION Wisconsin Univ., Madison. Inst. for Research on Poverty.
REPORT NO IRP-DP-531-78
PUB DATE Dec 78
NOTE 33p.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Factor Analysis; *Goodness of Fit; Information Sources; *Mathematical Models; *Parental Background; *Reliability; Socioeconomic Status
IDENTIFIERS *Joreskog (Karl G)

ABSTRACT

An important class of applications of measurement error or constrained factor analytic models consists of comparing models for several populations. In such cases, it is appropriate to make explicit statistical tests of model similarity across groups and to constrain some parameters of the models to be equal across groups using a priori substantive information. This paper discusses a statistical model developed by K. G. Joreskog for these purposes. The model is applied to children's and parents' reports of parental socioeconomic statuses for several grade levels. The analysis, which includes data from sons' reports of the schooling and occupations of their mothers and fathers, suggests that children do not approach their parents' level of reporting accuracy at the same rate for all characteristics; however, by twelfth grade, sons and parents are equally reliable for all characteristics considered. (Author/GC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

AUG 1 1979

ED174741

#531-78

INSTITUTE FOR RESEARCH ON POVERTY DISCUSSION PAPERS

A MULTIPLE GROUP MEASUREMENT MODEL OF CHILDREN'S REPORTS OF PARENTAL SOCIOECONOMIC STATUS

Robert D. Mare
William M. Mason

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
F. Skidmore
Inst. for Research on Poverty
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

UNIVERSITY OF WISCONSIN - MADISON

UD019709

A Multiple Group Measurement Model of Children's Reports of Parental Socioeconomic Status

Robert D. Mare
Department of Sociology
University of Wisconsin-Madison

and

William M. Mason
Population Studies Center
University of Michigan

December, 1978

We are indebted to Alan C. Kerckhoff for making available to us the data used in this paper. This research was supported in part by funds granted to the Institute for Research on Poverty at the University of Wisconsin-Madison by the Department of Health, Education, and Welfare pursuant to the provisions of the Economic Opportunity Act of 1964.

ABSTRACT

An important class of applications of measurement error or constrained factor analytic models consists of comparing models for several populations. In such cases it is appropriate to make explicit statistical tests of model similarity across groups and to constrain some parameters of the models to be equal across groups using a priori substantive information. This paper discusses a statistical model developed by Jöreskog for these purposes. The model is applied to children's and parents' reports of parental socio-economic statuses for several grade levels.

A Multiple Group Measurement Model of Children's Reports of Parental Socioeconomic Status

Much recent research has been concerned with measurement error and its implications for linear models of sociological phenomena. The literature is now rich with attempts to model and estimate measurement error, and to use the resulting models to construct more sophisticated structural equation models (Goldberger and Duncan, 1973; Bielby and Hauser, 1977b). Within this framework, an important class of applications consists of intergroup comparisons of measurement or constrained factor analytic models relating observable indicators to unobservable latent variables. This may consist of estimating a measurement or factor model for the same population at two points in time, or of comparing the models for several populations at a point in time. For example, Mason, Czajka, and Arber (1976) examine change in sex-role attitude factor models between the early and the mid-seventies. Bielby, Hauser, and Featherman (1977a) estimate response error models for measures of socioeconomic attainment in the black and nonblack populations. And Mason et al. (1976) compare the accuracy of children's reports of parental socioeconomic statuses for different age-race groups. In each case separate models of the relationships between unobserved and observed variables and among the unobserved variables themselves are specified for the groups of interest. The pattern and the strength of these relationships, both within and across populations, is a central substantive concern.

Thus far, most comparisons of measurement error and factor analytic models for two or more groups have been deficient because they estimated models independently for each group. That is, they have lacked a common framework within which to estimate the models for all groups simultaneously.

For example, in contrasting the response error patterns of children of different age groups, Mason et al. (1976) estimate separate models for each group, allowing all group differences to be reflected in the parameter estimates. In general, this procedure has two important limitations. First, it precludes statistical tests of group differences in the measurement models. A test for group differences requires a comparison of two models: (1) a model in which the specifications (or parts of them) for the several groups are constrained to be the same; and (2) an unconstrained model in which the specifications (or parts of them) vary across groups. Model (2) always fits the data better than (1) because it has more parameters. The test consists of assessing the statistical significance of the improvement in fit in going from model (1) to model (2). The test requires a framework for, first, obtaining pooled (constrained) estimates for the several groups and, second, estimating the unconstrained model for all groups simultaneously. Estimating separate models for each group does not permit the explicit comparison required by the test.

A second limitation of estimating the models of each group independently from the others is that it fails to exploit intergroup similarity in measurement models, resulting in less reliable parameter estimates than would otherwise be possible. Groups may differ in part of their measurement error pattern, but be invariant in others. For example, the correlations between attitude constructs may change over time, reflecting changes in ideology, but the relationships between attitude constructs and specific response items may not change, reflecting that the constructs are valid. A reasonable strategy, then, is to hold constant some elements of the models and allow variation where substantive reasoning indicates that it may occur. This affords better parameter estimates because they

are based on more observations (due to pooling groups) and use fewer degrees of freedom (due to between-group equality constraints).

There is a statistical framework for the simultaneous estimation of measurement models in several populations (Jöreskog, 1971).[1] To date, however, it has received little use in social research, despite the common task of comparing measurement or restricted factor analytic models across groups. This paper illustrates the use of the framework through a substantive example, namely age variation in the reliability of children's reports of parental socioeconomic characteristics. We analyze the data and draw upon the substantive arguments of Mason et al. (1976), and thus refine this earlier work.

This paper is divided into five sections, with a brief conclusion. First, it reviews the problem of response unreliability in children's reports of parental characteristics. Second, it presents a measurement model for children's and parents' reports for a single population and discusses its weaknesses. Third, it outlines a multiple-group approach to measurement error estimation, and applies Jöreskog's (1971) framework to the substantive problem at hand. Fourth, it discusses alternative specifications of the measurement model in connection with specific hypotheses. Finally, it presents empirical results.

1. ERRORS IN CHILDREN'S REPORTS OF PARENTAL SOCIOECONOMIC STATUS

The measurement reliability of socioeconomic characteristics is important in understanding the socioeconomic attainment process. Survey respondents make errors in reporting their own and others' socioeconomic statuses, reporting errors may be nonrandom, and groups may differ in the extent and pattern of their errors. Thus inferences based on attainment models depend on whether such models explicitly take account of

measurement error (Bielby and Hauser, 1977a; Bielby, Hauser, and Featherman, 1977a, 1977b; Broom et al., 1978).

Problems of measurement error in achievement process studies are more serious when children are the survey respondents who supply information on parental socioeconomic characteristics. This is typically the case in studies of the early achievement process. Since knowledge of social statuses is acquired through socialization, young persons may have a seriously incomplete picture of their parents' social standing and, therefore, make considerable errors in reporting their parents' characteristics (Mason et al., 1976, and references cited therein). The reliability of children's responses about parental characteristics varies with age. For whites, Mason et al. (1976) show that elementary school children are noticeably less reliable than their parents themselves, whereas high school youths approach their parents in reporting accuracy. Children's reporting errors may be nonrandom and the incidence of nonrandomness may depend on the particular parental socioeconomic characteristic for which information is elicited. Mason et al. (1976) show that white elementary school children's response errors for father's and mother's grades of school completed are positively correlated, whereas reporting errors for other pairs of parental statuses for elementary school children, and for all pairs of statuses for older children, are essentially random.

These findings on the quality of children's reports by grade level are based on measurement models estimated separately for each of three grades. As a result, the between-grade findings are not supported by statistical tests. In addition, separate estimation for each group results in less than optimal estimates of measurement model parameters. As will be discussed below, some parameters of the measurement models should not

vary across grade levels. Estimating a separate model for each group, therefore, requires estimating more parameters than are needed, reducing the reliability of parameter estimates.

In the following discussion, we outline a measurement model for a single grade level, point out where between-group constraints can produce a parsimonious multiple group model, and discuss the simultaneous measurement model.

2. A SINGLE GROUP MEASUREMENT MODEL

Our data consist of parental and children's reports on three parental socioeconomic characteristics--father's occupation, father's grades of schooling, and mother's grades of schooling--for children in the sixth, ninth, and twelfth grades.[2] A strategy for modelling children's response errors is to specify linear covariance structure models of parental and child reports. Parents' and children's reports of the same parental characteristics are viewed as linear functions of a common, unobservable true parental status. For each grade level, for the ith individual, the model can be written as follows:

$$\text{FAFED}_i = \text{TRFED}_i + \varepsilon_{1i} \tag{1}$$

$$\text{MOMED}_i = \text{TRMED}_i + \varepsilon_{2i} \tag{2}$$

$$\text{FAFOC}_i = \text{TRFOC}_i + \varepsilon_{3i} \tag{3}$$

$$\text{SOFED}_i = \lambda_4 \text{TRFED}_i + \varepsilon_{4i} \tag{4}$$

$$\text{SOMED}_i = \lambda_5 \text{TRMED}_i + \varepsilon_{5i} \tag{5}$$

$$\text{SOFOC}_i = \lambda_6 \text{TRFOC}_i + \varepsilon_{6i} \,. \tag{6}$$

TRFED is father's true (unobservable) grades of schooling completed, and FAFED and SOFED are father's and son's reports of father's schooling respectively. Similarly, TRMED is mother's true grades of school completed, and MOMED and SOMED are mother's and son's reports of mother's schooling respectively. TRFOC is father's true occupational status score, and FAFOC and SOFOC are the status scores of father's and son's reports of father's occupation. The λ's are parameters to be estimated from the data, and the parameters λ_1, λ_2, and λ_3 have been set equal to unity in equations (1), (2), and (3) to identify the model. The ε's are stochastic disturbances assumed to have constant variance within each equation. All variables are expressed as deviations from their respective means.

To complete the model, we specify the pattern of covariances among the true parental characteristics and among the errors in the six equations. True scores are allowed to covary freely, providing estimates of the covariances among parental characteristics corrected for measurement error. Error covariances are specified as free or zero, depending upon the extent to which respondents use information on one status characteristic in reporting another.

Thus we have a six equation measurement model for each grade level. The three coefficients relating sons' reports to their respective true parental statuses, the six elements of the covariance matrix of the true parental statuses, and the variable number of elements of the covariance matrix of the errors are estimated by the method of maximum likelihood. The model's adequacy in reproducing the observed covariance matrix of parents' and children's reports is evaluated by a goodness-of-fit statistic (Jöreskog, 1969). The extent of nonrandom measurement error is

given by the model itself (that is, by the between-equation covariances of ε's). The reliabilities of the reports are calculated from the parameter estimates. For example, consider fathers' and sons' reports of fathers' schooling (FAFED and SOFED). Let $\hat{\phi}_{11}$ be the estimated variance of TRFED, $\hat{\psi}_{11}$ be the estimated variance of the disturbance ε_1, and $\hat{\psi}_{44}$ be the estimated variance of the disturbance ε_4. Then the reliability of FAFED is

$$\frac{\hat{\phi}_{11}}{\hat{\phi}_{11} + \hat{\psi}_{11}} \tag{7}$$

and the reliability of SOFED is

$$\frac{\hat{\lambda}_4^2\hat{\phi}_{11}}{\hat{\lambda}_4^2\hat{\phi}_{11} + \hat{\psi}_{44}} \quad . \tag{8}$$

That is, an indicator's reliability is the fraction of its expected variance due to the variance of its corresponding true score.

Following our earlier discussion, this model has several limitations. First, comparisons across grade levels can be casual at best since estimating the models independently affords no formal way of testing between-grade differences.

Second, between-grade comparisons of children's reporting reliabilities are affected by extraneous sources of grade to grade variation. The reliability of children's reports cannot be assessed independently of the true parental status distributions and parents' reports of their statuses. Both the true characteristics and parents' reports of them, however, vary across grades due to sampling variability. Thus parameter estimates

describing the relationship between true parental statuses and children's reports of them--and thus the estimated child report reliabilities--vary quite apart from the effects of maturation. Fluctuations in the quality of parental reports need not induce systematic biases in the reliability estimates for children, but they do reduce the precision of the reliability estimates.

Finally, ignoring natural sources of invariance across grades and estimating separate models for each group results in unnecessary complexity. As discussed below, one can combine the information for all grades to estimate a single set of true parental status covariances and parental report reliabilities. This relatively parsimonious formulation fits the data at hand. Estimating a separate model for each group, therefore, requires many more parameters than are needed to describe the data.

3. A MULTIPLE GROUP MEASUREMENT MODEL

Superior reliability estimates of parents' and children's reports and explicit statistical tests of between-grade measurement model differences can be obtained using a framework that simultaneously estimates the measurement parameters for all grade levels. According to the model described above, separate sets of parameters for covariances among true parental characteristics and for the error variances of parental reports are estimated for each group. In general, therefore, the estimated reliabilities of parental reports will vary over children's grade levels. But although children's reporting performance can be expected to vary with children's ages (as a result of the learning process), parents' performances should not depend upon children's ages. Nor should the joint distribution

of true parental characteristics vary by children's ages.[3] Thus we seek a model that allows the parameters reflecting children's reporting to vary by age, but that constrains the parental performances and status distributions to be stable over children's ages. In particular, we wish to modify the model described above by constraining the true status covariance matrix and the disturbance variances for parental reports to be invariant across grade levels. Such models may be estimated in Jöreskog's (1971) general framework for the simultaneous covariance structure analysis of multiple populations. Within this framework it is possible to specify both group invariant and group specific parameters and to assess the adequacy of inter and intragroup parameter restrictions through goodness-of-fit statistics.

Jöreskog's model is applied to our measurement error problem as follows. We estimate equations (1) through (6) above for each of three populations. Suppressing the individual level subscript i, we can express these equations in the matrix form

$$\underline{X}_j = \underline{\Lambda}_j \underline{F}_j + \underline{\varepsilon}_j \ , \tag{9}$$

where $\underline{X}_j$ is a 6 × 1 vector of observed parental and child reports expressed as deviations from their means, $\underline{\Lambda}_j$ is a 6 × 3 matrix of coefficients, $\underline{F}_j$ is a 3 × 1 vector of true parental status variables, $\underline{\varepsilon}_j$ is a 6 × 1 vector of disturbances, and j = 1,2,3. The covariance matrix of the observed variables is then

$$\mathcal{E}(\underline{X}_j \underline{X}'_j) = \underline{\Lambda}_j \underline{\Phi}_j \underline{\Lambda}'_j + \underline{\Psi}_j \ ,$$

where

$$\underline{\Phi}_j = \mathcal{E}(\underline{F}_j\underline{F}'_j)$$

and

$$\underline{\Psi}_j = \mathcal{E}(\underline{\varepsilon}_j\underline{\varepsilon}'_j),$$

where $\mathcal{E}$ denotes the expectation operator. When we stipulate that the joint distribution of true parental statuses and the reliability of parents' reports are invariant, we require that

$$\underline{\Phi}_1 = \underline{\Phi}_2 = \underline{\Phi}_3 ,$$

$$\psi_{(11)1} = \psi_{(11)2} = \psi_{(11)3} , \tag{11}$$

$$\psi_{(22)1} = \psi_{(22)2} = \psi_{(22)3} ,$$

and

$$\psi_{(33)1} = \psi_{(33)2} = \psi_{(33)3},$$

where the last subscript of ψ refers to grade level and (11), (22), and (33) denote the first, second, and third diagonal elements of $\underline{\Psi}$ respectively, that is, the error variances of the equations for parents' reports of the three parental status characteristics. Equating the true score variances and the disturbance variances for parents' reports across groups guarantees, by the definition of reliability (7), that parental report

reliabilities are group invariant.[4] To complete the model the form of $\underline{\Psi}$, the error covariance matrix for each grade level, must be specified. We consider the form of $\underline{\Psi}$ below.

4. SPECIFICATIONS AND HYPOTHESES

This section discusses the range of measurement model specifications possible within the framework outlined above and presents hypotheses to guide the interpretation of the empirical results. Equations (1) through (6) show parents' and sons' reports as linear functions of unmeasured true parental statuses. Equation (10) expresses the observed status report covariances as functions of true status and disturbance covariances. Equation (11) states the between group equality restrictions on the true parental characteristics and the error variances of parents' reports. What remains to be specified is the pattern of parents' and sons' measurement errors. We must determine whether the model implies that reports of parental status characteristics are independent or whether some of the reports depend upon one another.

To specify whether reports depend only upon the true status they represent or upon reports of other status characteristics as well is to set the form of the disturbance covariance matrix $\underline{\Psi}_j$. The general form for the jth grade group is given in Figure 1. Since $\underline{\Psi}_j$ is symmetric it can be partitioned into three distinct 3 × 3 submatrices of disturbance covariances: $\underline{\Psi}_{11}$ for parents' reports, $\underline{\Psi}_{(22)j}$ for sons' reports, and $\underline{\Psi}_{(12)j}$ between parents' and sons' reports. The j-subscript is not used with $\underline{\Psi}_{11}$, since the covariances among parents' reports do not vary across grade levels of their sons. The elements of $\underline{\Psi}_{(22)j}$ and $\underline{\Psi}_{(12)j}$,

$$\left(\begin{array}{ccc|cc} \psi_{11} & & & & \\ \psi_{12} & \psi_{22} & & & \\ \psi_{13} & \psi_{23} & \psi_{33} & & \\ \hline \psi_{(14)j} & \psi_{(24)j} & \psi_{(34)j} & \psi_{(44)j} & \\ \psi_{(15)j} & \psi_{(25)j} & \psi_{(35)j} & \psi_{(45)j} & \psi_{(55)j} \\ \psi_{(16)j} & \psi_{(26)j} & \psi_{(36)j} & \psi_{(46)j} & \psi_{(56)j} \end{array} \right. \left. \begin{array}{c} \\ \\ \\ \psi_{(66)j} \end{array} \right) = \left(\begin{array}{c|c} \underline{\psi}_{11} & \underline{\psi}_{(12)j} \\ \hline \underline{\psi}_{(12)j} & \underline{\psi}_{(22)j} \end{array}\right)$$

Figure 1. General form of the disturbance covariance matrix for the jth grade level ($\underline{\psi}_j$).

on the other hand, are indexed by sons' grades, to indicate that the pattern of error covariances may be age dependent.

For each group there are a number of possible error patterns. The simplest is random error. In this case $\underline{\Psi}_j$ is diagonal for each grade level, where the diagonal elements are the error variances of sons' and parents' reports. If errors are not random, then it is necessary to consider several forms of nonrandomness. One form is nonrandomness among sons' reports, implying nonzero covariances among the errors in sons' reports, that is, nonzero off-diagonal elements in submatrix $\underline{\Psi}_{(22)j}$. In general, $\underline{\Psi}_{(22)j}$ is not the same for all j, since patterns of nonrandomness among sons' reports will vary by grade level. A second form is nonrandomness among parents' own status reports. This implies nonzero off-diagonal elements in submatrix $\underline{\Psi}_{11}$ of Figure 1. In contrast to the error covariances for sons' reports, those for parents' reports should not vary across sons' grade levels. The third type of nonrandom disturbances is between parents' and sons' reports. Nonzero covariances between the disturbances of parents' and sons' reports imply nonzero elements in submatrix $\underline{\Psi}_{(12)j}$ in Figure 1. This class of disturbance covariances, although logically possible, is of minimal substantive interest here. It is difficult to conceive of mechanisms generating covariances between parents' and sons' reporting errors.

A second range of possibilities reflects alternative assumptions about children's changing report reliability across grade levels. Although parental reporting reliability and status distributions are assumed constant across grade levels from the outset, sons' report reliabilities are initially assumed to vary. In some cases, however, estimates of

sons' reliabilities may turn out to be essentially unchanging across grades, even though we have not assumed this in advance. In addition, for some grade levels, sons' report reliabilities may turn out not to differ from those of their parents (Mason et al., 1976). In such cases it is desirable to reestimate models that explicitly incorporate these findings.

To do so requires constraints on the elements of $\underline{\Lambda}_j$ and $\underline{\Psi}_j$. Consider the covariance matrix $\underline{\Psi}_j$ in Figure 1, along with the coefficient matrix of the jth group:

$$\underline{\Lambda}_j = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ \lambda_{4j} & 0 & 0 \\ 0 & \lambda_{5j} & 0 \\ 0 & 0 & \lambda_{6j} \end{pmatrix}$$

Insofar as we wish to allow the reliability of sons' reports to vary across grade levels, we place no restrictions on the elements of $\underline{\Lambda}_j$ and $\underline{\Psi}_j$. But if, for example, we want to specify a priori that the reliabilities of sons' reports of fathers' occupations for ninth and twelfth grade sons are equal, we impose the constraints $\lambda_{62} = \lambda_{63}$ and $\psi_{(66)2} = \psi_{(66)3}$. If we want to specify a priori that twelfth grade sons report mothers' schooling as reliably as their mothers, then we impose the constraints $\lambda_{53} = 1.0$ and $\psi_{(55)3} = \psi_{22}$.

There are many possible specifications, and substantive reasoning is required to select a reasonable class of models from which to seek a

model that fits the data. Such reasoning is developed at length by Mason et al. (1976) and is briefly summarized below. The discussion is organized around the hypothesis that reporting reliability and the incidence of nonrandom reporting errors vary by sons' ages and the parental status being reported.

Variations in Reliability by Age

Boys in lower grades are more likely than boys in higher grades to report their parents' statuses with error. As boys grow older their sensitivity to dimensions of social stratification increases. Older boys, moreover, will simply have heard more often what their parents' educational attainments and occupations are. At some point, therefore, sons' and parents' reporting reliability can be expected to converge.

Variations in Reliability by Parental Characteristics

We seek reliability estimates for reports of three parental statuses: mother's and father's grades of school completed, and father's occupation. Children may not learn these three characteristics at the same rate, implying that their report reliability will vary by the characteristics that they are asked about. In contrast with father's occupation, which is current and tangible, parental education is remote and relatively abstract. Children may frequently hear about the kind of work their fathers do, but possibly less often how far their parents went in school. Thus sons may be better reporters of their father's occupation than of the educational attainment of either parent, and may approach their parents' report reliability for father's occupation at a lower grade level than for their parents' educational attainments.

Variations in Nonrandom Error by Age

Respondents uncertain about parental characteristics they are asked to report may use their knowledge of other statuses to help them. Operationally, this implies nonzero covariances between the errors in respondents' reports. If nonrandom reporting errors result from uncertainty, then the least knowledgable respondents--boys in the lowest grades--will be most likely to have nonzero error covariances.

Variations in Nonrandomness by Parental Characteristics

Not all reporting errors, however, are equally likely to be nonrandomly distributed. Mother's and father's grades of schooling are reported in response to a common stimulus, that is, a request for the highest grade of school completed by each parent, and thus sons may resolve their uncertainty by making these two measures agree. Such agreement results, therefore, from a common basis of measurement for the variables, rather than from a sophisticated appreciation of assortative mating. Conversely, other types of nonrandom error are less common because they presuppose too sophisticated an understanding of social stratification. A boy uncertain of his father's schooling might guess it from his father's occupation. But the sons most likely to be uncertain of their parent's statuses--the youngest--are least likely to have the understanding to make informed guesses. Such sophisticated forms of nonrandom error therefore are unlikely to occur.

5. EMPIRICAL RESULTS

This section presents the results of our measurement error model estimation for young white males. We first present summary goodness-of-fit

statistics for a number of specifications. Then we discuss the parameter and reliability estimates for the model we deem best, interpreting these results in light of the arguments presented above.

Several criteria, in addition to goodness-of-fit, are used to select a "best" model. First, parameter estimates should imply that both parents and sons report parental status with at least some error. Although equations (1) through (6) of the model require this, some empirical versions of the model may imply zero or negative error variances, suggesting that the model is misspecified. Second, the parameter estimates should imply reliability estimates for sons' reports that are stable or increasing with grade level. If estimates imply that sons' reporting performances deteriorate with age, this suggests either an incorrectly specified pattern of error covariances or implausible estimates resulting from sampling variability. In the latter case, a specification that equates sons' report reliabilities over grade levels is in order. Third, parents' own status reports should be at least as reliable as their sons' reports. And finally, the error covariance pattern must be substantively interpretable.

In selecting a measurement model we sought a plausible pattern of error covariances which fits the data, and then, given this pattern, considered alternative sets of between-grade reliability constraints to find the point where boys are as reliable respondents as their parents.

Table 1 presents goodness-of-fit statistics for eight distinct specifications.[5] Each of these specifications requires the estimation of equations (1)-(6) simultaneously for sixth, ninth, and twelfth grade boys. In addition, each specification incorporates the intergrade equality

Table 1

Goodness of Fit Statistics for Measurement Models for Sixth, Ninth, and Twelfth Grade White Males

Model[a]	χ^2	Degrees of Freedom	Probability
A. Random errors	67.7	36	.001
B. Covariances among all sons' errors for all grades	36.1	27	.113
C. Covariances between errors in sons' reports of fathers' and mothers' schooling for 6th graders	50.9	35	.040
D. Covariances between errors in sons' reports of fathers' and mothers' schooling for 6th and 9th graders	44.2	34	.112
E. Model D with reliabilities of 12th grade sons' reports of fathers' occupation and schooling equated to reliabilities of fathers' reports	47.5	38	.140
F. Model D with reliabilities of all 12th grade sons' reports equated to parents' report reliabilities	49.2	40	.151
G. Model D with reliabilities of all 12th grade sons' reports and 9th grade sons' reports of mothers' schooling and fathers' occupation equated to parents' report reliabilities	50.5	44	.233
H. Model D with reliabilities of all 9th and 12th grade sons' reports equated to parents' report reliabilities	59.0	46	.098

[a]In all models the covariance matrix of true parental characteristics and the error variances of parents' reports are held constant across grades.

restrictions for parents discussed above: to wit, the covariance matrix of the unobservable true parental status reports and the error variances of parental reports of their socioeconomic characteristics are held constant across sons' grade levels.

Model A of Table 1 assumes that all reporting errors are random. The likelihood ratio chi-square value for this model is 67.7 with 36 degrees of freedom, indicating that random reporting errors are very unlikely to have generated the observed covariance matrices. In addition, this specification implies implausible reliability estimates (not shown here). All reliabilities for twelfth grade sons' reports and one reliability for ninth grade sons' reports exceed the corresponding parents' report reliabilities. Evidently a more complex model is required.

Previous analysis of these data indicates that the only significant correlation in the errors of sons' reports is for the reports of mother's and father's schooling for sixth graders (Mason et al., 1976). To see whether a similar finding results from the present estimation framework, we first consider a less parsimonious model in which all sons' errors are mutually correlated (Model B in Table 1). Both the sizes of the error correlations implied by the estimated error covariances and their standard errors will suggest which error covariances should be retained in the model. With a loss of 9 degrees of freedom (one for each error covariance in each of the three grade levels), the chi-square statistic drops by more than 30, a highly significant improvement in fit. The standard errors of the error covariances (not shown here), however, indicate that all but two of the nine covariances are not significantly different from zero. These are the covariances for both sixth and ninth graders between the sons' errors in reporting father's and mother's schooling.

Models C and D in Table 1 are suggested by the above findings. The first assumes a single error covariance for sixth graders between sons' reports of parents' educational attainments, the model implied by the earlier analysis. The second assumes that the error covariances between sons' reports of parents' schooling occur for both sixth and ninth grade sons. Plainly the latter has a superior fit. Model C is a clear improvement upon the purely random error model, but, for the additional degree of freedom required to estimate Model D, the chi-square statistic drops by more than 6 points. The descriptive levels of significance in the last column of the table show, moreover, that Model D is as likely to have generated the sample covariances as Model B, in which all sons' disturbances are correlated.

We next consider whether Model D implies reasonable estimates of sons' and parents' report reliabilities. Table 2 presents reliabilities calculated from the parameter estimates of the model. For each of the three parental socioeconomic characteristics sons' reporting reliabilities increase monotonically with grade level. These estimates imply, however, that for both fathers' characteristics twelfth grade sons are more reliable respondents than their fathers. To see if these anomalies are due to sampling fluctuations, we can estimate a more constrained model, which retains the present pattern of disturbance covariances, but equates the reliabilities for sons' and parents' reports. If these constraints do not make the model fit significantly worse than Model D, then we have adequately characterized the data.

In addition to rectifying the anomalously high sons' reliabilities in Table 2, we also want to see the point at which sons' and parents' reports are equally accurate. Table 2 suggests that not only twelfth

Table 2

Estimated Reliabilities of Sons' and Parents' Reports of Parental Socioeconomic Characteristics, by Grade

Characteristic	Reporter	Grade of Son 6	9	12
Father's Schooling	Father	.853	.853	.853
	Son	.611	.760	.944
Mother's Schooling	Mother	.890	.890	.890
	Son	.498	.862	.870
Father's Occupation	Father	.915	.915	.915
	Son	.710	.908	.937

NOTE: The model includes error covariances between sons' reports of father's and mother's schooling for sixth and ninth grade white boys (Model D in Table 1).

grade sons' reports of fathers' statuses, but also their reports of mothers' schooling and at least some of the ninth graders' reports may be as reliable as the corresponding parents' reports. Hence we estimate a variety of models, making differing assumptions about the point at which sons' and parents' reports are equally reliable.

Goodness-of-fit measures for alternative between-grade equality specifications appear in Table 1 (Models E, F, G, and H). Model E, which has equal parent and son reliabilities for twelfth graders' reports of fathers' characteristics, preserves the satisfactory fit of Model D. Models F and G further improve the specification through additional equality constraints between sons' and parents' report reliabilities. The excellent fit of Model G suggests that twelfth graders report all three parental statuses as reliably as parents, and that ninth graders report both mothers' schooling and fathers' occupation as well as the parents. If we go on to Model H, however, and equate ninth grade sons' and their fathers' reliabilities for fathers' schooling, the fit of the model deteriorates markedly.

The analysis suggests that children do not approach their parents' level of reporting accuracy at the same rate for all characteristics, but that by twelfth grade, sons and parents are equally reliable for all characteristics we consider. Parameter and reliability estimates for Model G, which embodies these findings, appear in Table 3. The reliability estimates for parents' and sons' reports given in the final column of the table confirm several of the arguments made above. First, they show that sixth graders are only one-half to two-thirds as reliable respondents as twelfth graders and their parents. Second, the estimates show that boys report father's occupation more accurately than the schooling of either

Table 3

Model H Parameter Estimates

Characteristic	Reporter	True Score Variances $\hat{\phi}$	Error Variances $\hat{\psi}$	Slope $\hat{\lambda}_{ij}$	Reliability $\frac{\hat{\lambda}^2_{ij}\hat{\phi}_{ij}}{\hat{\lambda}^2_{ij}\hat{\phi}_{ij}+\hat{\psi}_{ij}}$
Father's Schooling	6th Grade Son	5.82	2.19	0.74	.592
	9th Grade Son		1.73	0.90	.732
	12th Grade Son		0.69	1.00	.894
	Father		0.69	1.00	.894
Mother's Schooling	6th Grade Son	3.00	2.34	0.89	.505
	9th Grade Son		0.44	1.00	.873
	12th Grade Son		0.44	1.00	.873
	Mother		0.44	1.00	.873
Father's Occupation	6th Grade Son	514.68	182.64	0.94	.711
	9th Grade Son		45.78	1.00	.918
	12th Grade Son		45.78	1.00	.918
	Father		45.78	1.00	.918

True Score Covariances ($\underline{\Phi}$)

		1	2	3
1.	Father's Schooling	5.82		
2.	Mother's Schooling	2.68	3.00	
3.	Father's Occupation	40.70	20.61	514.68

Error Covariances ($\underline{\Psi}_{(12)j}$) and Correlations between Son's Reports of Mother's and Father's Schooling

	Covariance	Correlation
6th Grade	1.11	.57
9th Grade	.40	.39

parent. These differences occur at every grade level, though they are generally weaker at the higher grade levels. Finally, white boys do not favor either parent in reporting grades of schooling. Father's schooling is reported somewhat more reliably than mother's by sixth and twelfth graders, but the opposite is true for ninth graders.

6. CONCLUSION

This paper has illustrated the use of the simultaneous factor analytic methods developed by Jöreskog (1971) in estimating measurement models for children's reports of parental socioeconomic characteristics at various grade levels. By estimating models for all grade levels simultaneously, we have used the structure of the data to obtain estimates superior to those obtainable from estimating separate models for each group. In particular, we have held equal those parameters that should be naturally stable across groups (except due to sampling variability). This produces a more parsimonious and reliable model for the several groups taken together. In addition, the simultaneous estimation permits explicit statistical tests of group differences in measurement error patterns, permitting further model simplification.

APPENDIX

Table A1

Covariance Matrices for White Sixth, Ninth, and Twelfth Grade Sons' and Parents' Reports of Parental Socioeconomic Characteristics

	1.	2.	3.	4.	5.	6.
Sixth Grade						
1. SOFED	5.86					
2. SOMED	3.12	3.32				
3. SOFOC	35.28	23.85	622.09			
4. FAFED	4.02	2.14	29.42	5.33		
5. MOMED	2.99	2.55	19.20	3.17	4.64	
6. FAFOC	35.30	26.91	465.62	31.22	23.38	546.01
Ninth Grade						
1. SOFED	8.20					
2. SOMED	3.47	4.36				
3. SOFOC	45.65	22.58	611.63			
4. FAFED	6.39	3.16	44.62	7.32		
5. MOMED	3.22	3.77	23.47	3.33	4.02	
6. FAFOC	45.58	22.01	548.00	40.99	21.43	585.14
Twelfth Grade						
1. SOFED	5.74					
2. SOMED	1.35	2.49				
3. SOFOC	39.24	12.73	535.30			
4. FAFED	4.94	1.65	37.36	5.39		
5. MOMED	1.67	2.32	15.71	1.85	3.06	
6. FAFOC	40.11	12.94	496.86	38.09	14.91	538.76

NOTE: Item identifications are: SOFED = son's report of father's occupation, SOMED = son's report of mother's schooling, SOFOC = son's report of father's occupation, FAFED = father's report of his schooling, MOMED = mother's report of her schooling, FAFOC = father's report of his occupation.

NOTES

[1]Since this paper was written, software has become available for estimating simultaneous equation models with both observed and unobserved variables in multiple populations (Jöreskog and Sörbom, 1978). Although these models are more complex than the ones discussed in this paper, their logic and rationale are similar.

[2]For a full description of the sample design and the complete data set, see Kerckhoff (1974). The data derive from a 1969 sample of approximately 500 Fort Wayne, Indiana black and white sixth, ninth, and twelfth grade males and their parents; however, the present analysis is based only on the white sample. The boys and their parents reported parental statuses in independent interviews. Parents' schooling is measured in grades completed, and father's occupation is measured by the Duncan socioeconomic index. Appendix Table A1 presents the covariance matrices of children's and parents' reports for the three grade levels used in the analysis. Covariances are pairwise present, that is, calculated over all nonmissing observations on each pair of variables. Variances are based on the maximum numbers of nonmissing univariate observations.

[3]In principle, there may be slight nonsampling variability among parents by children's ages in cross-sectional data. On average, parents of older children are older than parents of younger children and may therefore have somewhat different status distributions insofar as socioeconomic charactersitics are related to age. Such variation, however, should be very small. In these data the most extreme age difference between groups of children averages 6 years. A corresponding 6-year age difference for their parents implies trivial differences

in their status distributions. Moreover, neither in the raw data nor in the earlier analyses of Mason et al. (1976) is there evidence of systematic variation in parental status distributions or parental report reliability by children's grade level.

[4]The converse, however, is not true. Equal reliability requires only that the ratio of the true score variance to the sum of the true score variance be equal, rather than the variances themselves. The restrictions given by (11), then, are stronger than a strict equal reliability condition requires. We impose these restrictions for two reasons. First, they are not unreasonable. Neither the distributions of true parental characteristics nor the parental reports' error variances should vary significantly by children's grade level. Second, the equal reliability restriction per se is nonlinear (see [7]), and therefore difficult to impose in practice.

[5]All models were estimated using the program SIFASP (van Thillo and Jöreskog, 1970).

REFERENCES

Bielby, W.T., and Hauser, R.M. 1977a. Response error in earnings functions for nonblack males. Sociological Methods and Research, 6, 241-280.

Bielby, W.T. 1977b. Structural equation models. Annual Review of Sociology, 3, 137-161.

Bielby, W.T., Hauser, R.M., and Featherman, D.L. 1977a. Response errors of black and nonblack males in models of the intergenerational transmission of socioeconomic status. American Journal of Sociology, 82, 1242-1288.

Bielby, W.T. 1977b. Response errors of nonblack males in models of the stratification process. Journal of the American Statistical Association, 72, 723-735.

Broom, L., Jones, F.L., McDonnell, P., and Duncan-Jones, P. 1978. Is it true what they say about daddy? American Journal of Sociology, 84, 417-426.

Goldberger, A.S., and Duncan, O.D. 1973. Structural equation models in the social sciences. New York: Seminar Press.

Jöreskog, K.G. 1969. A general approach to confirmatory maximum likelihood factor analysis. Psychometrika, 34, 183-202.

Jöreskog, K.G. 1971. Simultaneous factor analysis in several populations. Psychometrika, 36, 409-426.

Jöreskog, K.G. and Sörbom, D. 1978. LISREL IV: Analysis of linear structural relationships by the method of maximum likelihood. Chicago: National Educational Resources.

Kerckhoff, A.C. 1974. Ambition and attainment. Washington, D.C.: American Sociological Association.

Mason, K.O., Czajka, J.L., and Arber, S. 1976. Change in U.S. women's sex-role attitudes, 1964-1974. American Sociological Review, 41, 573-596.

Mason, W.M., Hauser, R.M., Kerckhoff, A.C., Poss, S.S., and Manton, K. 1976. Models of response-error in student reports of parental socio-economic characteristics. In W.H. Sewell, R.M. Hauser, and D.L. Featherman (Eds.), Schooling and achievement in American society. New York: Academic Press.

van Thillo, M. and Joreskog, K.G. 1970. SIFASP--A general computer program for simultaneous factor analysis in several populations (Research Bulletin 70-62). Princeton: Educational Testing Service.